Request for Proposal

Photovoltaic Power System

USS Saratoga Museum Foundation, Inc.

Issued by ENTECH Engineering, Inc. on
behalf of the USS Saratoga Museum Foundation, Inc.

April 25, 2004

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1. Introduction

The USS Saratoga Museum Foundation, Inc will be referred to as the **Purchaser**. The installer will be referred to as the **Contractor**.

2. Scope

The goal of this project is to install a utility grid interconnected 1,200-watt photovoltaic (PV) with battery backup system at the site of Juliet 484, a decommissioned former Soviet Union submarine moored in the Providence River at Collier Point Park, adjacent to the Manchester Street Generation Station. Completion of this project shall be no later than June 20th, 2004.

3. Deadline, Location, and Addressing Requirements

The deadline for submitting a response to this Request for Proposal is:

June 18, 2004, 5:00pm. BIDS MUST HAVE A POST MARK BEFORE THIS DEADLINE.

Responses are to be submitted to the following address:

Christopher Warfel
Entech Engineering, Inc.
P.O. Box 871
Block Island, RI 02807

The envelope is to have the following wording identifying it as this RFP:

USS SMF, Inc. Juliet 484 Photovoltaic System Request for Proposal

4. Proposal Submittal Forms

Proposals submitted in response shall utilize the forms provided in Appendix A.

5. Mandatory Pre-Bid Site Visit

A mandatory pre-bid site visit is required by all bidders.

The date of the pre-bid site visit is: May 21, 2004, 10:30 am.

Bidders are to meet at the Juliet 484 Ticket Booth at Collier Park.

6. Bid Ranking Criteria

Bids will be evaluated and awarded based upon the lowest responsible bid that meets the bid specification.

7. General Description of Project Requirements

General Description of Project Requirements includes the following:

a) An installed operational 1,200-watt, grid-interconnected photovoltaic power generation system with battery backup.

b) Engineering drawings showing the components of the complete system, including the PV array, attachment method and materials, inverter(s), balance-of-system hardware, and other information necessary to show the installation of the system. The complete electrical schematics shall detail the electrical circuitry from the panels to the interconnection to the facility's a/c distribution point.

d) Operation and Maintenance Training for up to two Purchaser designated personnel on the operation of the system, basic troubleshooting, periodic maintenance procedures, and proper record keeping.

e) Operation and Maintenance Manual that is comprised of the following sections:

1) Description of system operation
2) Schematic of system
3) Warranties
4) Material specification data sheets
5) Maintenance schedule
6) Maintenance log

Contractor will be responsible for obtaining, assembling, completing and submitting all permits, and utility interconnection, and net metering forms to the proper authorities. The purchaser will assist by providing any and all necessary utility data required to compile the net metering application forms.

8. Permits

The successful Contractor shall obtain all of the necessary permits from the City and/or State and furnish the same to the Purchaser before commencing work.

9. State and Federal Labor Laws/Licensing

The section is not used for this RFP.

10. Bonding

Successful bidder will be subject to a 10% Retainage until satisfactory completion of the project, as signified by a successful commissioning test.

11. Certificates of Insurance

The successful bidder shall furnish a certificate of the following insurance coverage prior to commencing work.

a) Comprehensive General Liability - $500,000 each occurrence, $1,000,000 aggregate with Product Liability
b) Vehicle Bodily Injury and Property Damage - $1,000,000 single limit
c) Worker's Comprehensive – State of Rhode Island, in accordance with Title IX

12. Asbestos

Asbestos is not known to be present.

13. Site Description and Conditions

This is a ground-mounted system. The location of the array is to be on the southern side of the historic coal ship off-loading apparatus shown in the PV Specification Appendix. The design voltage of the system is 48v DC.

The inverter and charge controller are to be located in compartment 5, Deck Two, or as designated during the site tour. Remote monitoring capability of the system will be required. The monitor display will be in the Ship's Office. An optional monitor display in the Safety Trailer is also desired.

The approximate distance from the photovoltaic array to the submarine entrance is 115'. The distance from the submarine entrance to the inverter, charge controllers, and batteries is approximately 115'.

The array and its attachment systems shall withstand the following ambient conditions and be designed for a twenty-five year life, assuming periodic maintenance.

- Sustained wind velocity per state building code or not less than 120 mph.
- Average humidity conditions from 10% to 100%
- Ambient temperature range from -40°C to 43°C
- Hail conditions to 1 inch in diameter per UL-1703
- Earthquake potentials in the Rhode Island Uniform Building Code

The array shall have a slope no less than 45 degrees, and no greater than 60 degrees.

A very important component of this RFP is the converting of inefficient incandescent and T12 fluorescent lightning to LED, CFL, and higher efficiency T8 Fluorescent/Electronic Ballast lighting. There are three types of fixtures with incandescent lighting. One of these is an unusual fixture, requiring the use of a very small CFL or an LED bulb. The other fixture types can use standard spiral CFL bulbs.

14. Insolation Data

The following site conditions for Providence, Rhode Island have been taken from the National Renewable Energy Laboratories publication: "*Solar Radiation Data Manual for Flat Plate and Concentrating Collectors: M35-A0266" for Providence, Rhode Island and* shall be used for the system performance and design.

Table 1. Insolation Availability for Providence, Rhode Island.

Month	Average Daily Insolation Availability (kWh/m^2)		
	Latitude Tilt-15°	Latitude Tilt+0°	Latitude Tilt+15°
January	3.0	3.4	3.6
February	3.7	4.1	4.2
March	4.5	4.7	4.6
April	5.1	5.0	4.6
May	5.6	5.3	4.7
June	5.9	5.4	4.7
July	5.9	5.5	4.8
August	5.5	5.3	4.7
September	4.9	5.0	4.7
October	4.1	4.4	4.4
November	2.9	3.2	3.3
December	2.5	2.9	3.1

15. System Electrical Design Parameters

Appendix B contains the Codes and Standards requirements.

16. Design Professional Requirements

16.1. Structural

The rack mounts must be installed per manufacturer's specification with documentation provided showing the system is rated for 120mph.

16.2. Electrical

A qualified registered professional engineer or Master Electrician in the State of Rhode Island must certify that the electrical design of the system meets all applicable electrical codes and standards.

17. Bidders Qualifications, Use of Photovoltaic System Subcontractor

This RFP is open to any electrical contractor, or general contractor registered in the State of Rhode Island. The submitter must provide documentation of a contractual relationship with a company that has installed at least two (2) grid interconnected photovoltaic projects.

18. Equipment/Installation Specifications

18.1. Photovoltaic Array

18.1.1. Array Orientation and Location

The array shall be located along the southern edge of historic coal ship offloading apparatus. The bottom of the panels shall be 2 feet from the ground and 5 feet from the south edge of the coal ship offloading apparatus.

18.1.2. Array Output

The total installed capacity of the system is to be rated at a nominal 1,200 watts (1.2 kWe) Direct Current

18.1.3. Module/Subassembly Requirements

The modules shall meet or exceed the requirements of IEEE Standard 1262-1995, Recommended Practice for Qualification of Photovoltaic (PV) Modules (April 12, 1996) and Underwriter Laboratories (UL) Standard 1703, Standard for Safety for Flat-Plate Photovoltaic Modules and Panels (May 17,1993). The contractor shall provide a complete description of the physical properties of the PV modules, including the results of the module qualification tests. Manufacturer schematics of the modules are acceptable.

NEMA 4 corrosion-resistant junction boxes with liquid tight conduit fittings are required. Fiberglass, PVC, stainless steel, or aluminum enclosures are acceptable. Consideration will also be given to designs that will allow drainage of condensation that occurs within the junction box. Painted steel or galvanized junction boxes are not permitted.

18.1.4. Mounting Hardware

Mounting to the footing assembly will be accomplished by the use of aluminum racks, and stainless steel bolts, nut, washers, etc.

The contractor is responsible for designing the array mounting, providing the array mounting hardware, foundations and installing all array hardware**.** Corrosion resistive materials shall be used.

18.1.5. Acceptable Module Manufacturers

Acceptable photovoltaic module manufacturers are in no particular order:

Solarex, BP, Astropower, Evergreen, ASE, Kyocera, Sharp, Shell

Alternates for acceptance shall be considered by following the procedure in Appendix B.

18.2. Power Conditioning Unit(s)/Inverter(s)

18.2.1. Specifications and Codes and Location

The Power Conditioning Units (PCUs) / Inverters shall be an Underwriter's Laboratory (UL) listed inverter that can operate in parallel with utility service and battery backup power. Final location is to be decided by Purchaser.

The PCUs shall be certified by Underwriters Laboratory for compliance to UL 1741. The PCU protection systems shall follow the IEEE 929 requirements, which are summarized below.

a) The PV system shall be capable of operating within the voltage limits specified in ANSI C84.1, Clause 2, Range B, utilization voltage. The inverter must sense abnormal voltage and respond. The following conditions shall be met, with voltages in RMS and measured at the Point of Common Coupling (PCC).

Voltage	Maximum Trip Time
V< 120 (V<50%)	6 cycles
120<V<212 (50%<V<87%)	120 cycles
212≤V≤254 (87%≤V≤106%)	Normal Operation
254<V<360 (106%<V<137%)	120 cycles
360<V (137%<V)	cycles

b) The PV system shall operate in synchronization with the utility and should have a fixed operating frequency range of 59.5-60.5 Hz. When the line frequency is outside the range of 59.5 to 60.5 Hz, the inverter must cease power transfer to the utility within 6 cycles.

c) DC injection into the AC interface at the PCC shall be less than 0.5% of rated inverter output under either normal or abnormal operating conditions.

d) The PV system output shall have low current harmonic levels to ensure that other equipment connected to the utility system suffers no adverse effects. The PV system electrical output at the PCC shall comply with IEEE Std 519-1992, Clause 10, "Recommended Practices for Individual Customers." The key requirements of this clause are summarized below:

Total harmonic current distortion shall be less than 5% of the fundamental frequency current at full system output. Each odd individual harmonic shall be limited to the percentages listed in the following table. The limits in this table are a percentage of the fundamental frequency current at

full system output. Even harmonics in these ranges shall be less than 25% of the odd harmonic limits listed.

Harmonics	Distortion Limit
3rd through 10th	4.0%
11th through 16th	2.0%
17th through 22nd	1.5%
23rd through 33rd	0.6%
above the 33rd	0.3%

e) At the PPC, the PV system shall operate at a power factor greater than 0.85 (lagging or leading) when output is greater than 10% of rating.

f) The PV system and interface equipment shall be grounded in accordance with applicable local codes.

g) The PV system shall have strategically located disconnects to provide visible isolation points to allow for safe work practices. The NEC dictates the requirements for these disconnect devices, allowing for essentially hazard free operation and maintenance of the electrical power equipment.

h) The system shall be capable of completely automatic, unattended operation, including wake-up, synchronization and disconnect.

i) PCU systems shall include all necessary self-protective features to protect the arrays and PCU from damage in the event of component failure or from parameters beyond safe range due to internal or external causes. Clearing of fuses shall not be the normal means of response to external line transients. Faults due to malfunctions within the PCU or PV system equipment, including commutation failures, shall be cleared by the PV system protection device and not by utility or customer protection devices.

j) Excessive solar power (solar enhancement) - During partly cloudy and cool conditions, the PV array may, for a brief period of time (< 5 minutes), operate above the system rating. The PCU should, at a minimum, protect itself from excessive power flow, or if possible, back the PV system off the maximum power point to allow continuous operation during solar enhancement. The PCU should resume normal operation automatically after such a solar enhancement has passed.

18.2.2. Acceptable PCU/Inverter Manufacturers

Xantrex Technology, Inc., Outback Power Systems

Alternates for acceptance shall be considered by following the procedure in Appendix B

18.3. PCU Non Electrical Performance

The PCU shall not produce excessive Electromagnetic Interference (EMI) and shall be in compliance with FCC EMI regulations/guidelines, Part 15, Subpart J, FCC Regulations.

The PCU shall be designed to minimize audible noise when the enclosure door is closed and minimize the transmission of noise/vibration through the enclosure mounts. The maximum PCU audible noise at a point two (2) meters in front the PCU shall be no more than 52 dba.

18.4. Battery System

A battery system will be required to operate in parallel with the existing utility service, and provide power in parallel to the submarine. In the event of a utility power failure, the battery system is to be capable of operating all power needs within the submarine for one (1) day.

Appendix G contains a computer model of the backup power needs. We calculate approximately 820 amp hours of required deliverable load, with a battery discharge of no greater than 70%.

18.5. Balance-of-System Components

All source circuits shall include protective features, such as blocking diodes, fuses, and voltage-limiting surge protection devices, unless it can be demonstrated that they are not needed to protect the source circuit. The contractor shall design for the installation of these components in a manner to allow convenient and safe replacement. The design basis shall address aging and maximum voltage and current characteristics of such devices.

Bypass and blocking diodes shall be included, unless they are not needed to avoid excessive power loss.

18.6. Wiring

a) All wiring shall be identified and specified. Each run shall be assumed continuous. Splices are not allowed. Wiring must comply per NEC.

b) Each conductor shall have identifying labels or markings on both ends. All field wiring between equipment shall be color-coded per ICEA standards.

c) Control and instrumentation wiring shall be separated from power and high-voltage wiring, if possible, by use of separate compartments or enclosures or by use of separate wire-ways and appropriate barrier strips within a common enclosure.

d) Wiring from the module to the inverters shall be placed such that it is hidden from ground viewing as much as possible. It is anticipated that the conduit-encased conductor will run from the panels to the inverters along the top of the trellis supporting structure. The conduit-encased conductor shall then run from the inverters along the top of the roof, near the edge of the roof to the point of entrance along the West outside wall.

e) Design voltage drop shall be less than 3%.

18.7. Utility Interconnection Point

Output from the photovoltaic system shall interface with the utility electrical system at the 220v 60amp (35amp fuse) panel located at the base of the observation deck.

19. Acceptance Tests

The contractor shall perform an Acceptance Test(s). Procedure for the specified system utilizing the Commissioning Forms provided in Appendix D. The procedure shall include a method to perform each test and the pass/fail criteria. It is required that the Purchaser shall witness these acceptance tests.

20. Service and Warranty

The Contractor shall provide a one-year system labor warranty at a minimum, and one-year maintenance service. This warranty shall include all parts, shipping, labor, and on-site service.

The Contractor shall be responsible for performing all scheduled maintenance including routine system checks, monthly electrical measurements, and /or any other required scheduled maintenance activity as determined by the Array and Inverter Manufacturer. The Purchaser shall assist in monitoring the operation of the system and shall provide unscheduled maintenance support upon request.

The purchaser shall report system problems to the contractor as they are discovered. Juliet 484 Failure Report shall be submitted by the purchaser to the contractor and shall include the following information:
1) when the problem was discovered and
2) the nature of the problem insofar as the purchaser can determine.

The report shall be telephoned or faxed to the contractor. Upon receipt, the contractor shall provide the appropriate assistance. It is understood that some troubleshooting by the purchaser, at the direction of the contractor, may be requested of the purchaser by the contractor to help identify the extent of the failure.

The contractor has three days to identify the cause of the failure. A Contractor Failure Report shall be submitted by the contractor to the purchaser and shall include the following information:
1) the cause of the failure
2) time to repair the failure
3) estimated cost to repair failure not covered by warranty

If the time to complete the repairs shall exceed three days a written letter of deviation shall be submitted to the purchaser estimating when the repairs shall be completed.

If the contractor has not responded within (3) three days from the date of Juliet 484 Failure Report, or the time to repair is longer than three (3) days the date of the Contractor Failure Report, the purchaser reserves the right to take recourse requesting financial compensation for the value of the energy not produced from the time of failure to the time of repair using Providence, Rhode Island solar insolation data, plus $100 per day for compensation of the loss opportunity of utilizing the system for expected educational purposes. Time to repair the system that is longer than three (3) days due to equipment availability shall be considered out of the control of the contractor and shall not be subject to recourse. All diligence must be demonstrated by the contractor to have unavailable equipment delivered and installed in the shortest reasonable time period possible.

21. Documentation / Drawings

21.1. Initial Submittals

The contractor shall provide documentation describing the design, component selection, and details of the complete system, including the PV array, power conditioner, batteries, balance-of-systems hardware, including complete electrical schematics.

21.2. Final Submittals

a) The Contractor shall provide final As-Built drawings describing the design, component selection, details of complete system, including PV array, power conditioner, batteries, balance of system including complete electrical schematic.

b) The Contractor shall provide documentation for the Operation and Maintenance of the Photovoltaic System per the requirements of 7.e)

c) A description of any special equipment and/or tools required for maintenance of the PV system.

APPENDIX A

Bid Submittal Forms

The following forms are designed to facilitate your response. Please follow this format. Reference added pages that are attached as appendices to your response.

1. Bidder Identification 1
2. Electrical Contractor Identification 1
3. Bidder References 2
4. Electrical Contractor References 3
5. Photovoltaic System Description 4
6. System Schematics 5
7. Required Maintenance 6
8. Warranties 7
9. Workforce 8
10. Price 9
11. Bid Information 10
12. Energy Produced at Proposed Orientation (kWhs/year) 10

ENTECH ENGINEERING'S USE

Time Received	Date Received	Receiver's Initials	Delivery Method (Mail or In-Person)

1. Bidder Identification

Company Name	
Address:	
Tax Identification Number	
Contact Name	
Title	
Phone Number	
Fax Number	
Email Address	

2. Electrical Contractor Identification

Company Name	
Address:	
Contact Name	
Title	
Phone Number	
Fax Number	
Email Address	

3. Bidder References

Project One Description Owner Contact Name: Contact Phone Number:	
Project Two Description Owner Contact Name: Contact Phone Number:	
Project Three	
Description 	
Owner	
Contact Name:	
Contact Phone Number:	

4. Electrical Contractor References

Project One	
Description	
Owner	
Contact Name:	
Contact Phone Number:	
Project Two	
Description	
Owner	
Contact Name:	
Contact Phone Number:	
Project Three	
Description	
Owner	
Contact Name:	
Contact Phone Number:	

5. Photovoltaic System Description

A one page (maximum) written description of the system and its operation is to be included below.

6. System Schematics

Schematic A: Schematic of Panel and Mounting System Layout (one page)
Schematic B: Schematic of Battery/Charge Controller Installation
Schematic C: Schematic of Inverter Installation (one page)

7. Required Maintenance

A periodic maintenance schedule is required, and the identification of whom will perform the maintenance for the next two years. If maintenance is to be subcontracted to another party, then it must be so stated.

Maintenance Schedule

Procedure Description	Frequency

8. Warranties

Item	Manufacturer	Years	Limitations
Modules			
Inverter			
Charge Controller			
Conductor			
Batteries			
Isolation Switchgear			
Labor			

9. Workforce

Project Manager

Personnel responsible for components of project.

Component	Name, Company, Address, Phone Number
Design	
Installation	
Routine Maintenance	
Troubleshooting	
	Maximum Guaranteed Response Time In Days to Determine a Problem.
	Maximum Guaranteed Response Time In Days to Repair A Problem Assuming No Equipment Supply Issues. If Equipment Supply Is An Issue, A Letter of Deviation Must Be Submitted.

10. Price

The bid price for the project is to be submitted with the understanding that it may be modified if additional information is presented by the Purchaser that alters this RFP's scope. Bids will be awarded in total.

Photovoltaic System	Subtotal	Total
A. Materials/Equipment		
B. Design		
C. Installation		
D. Total A, B, C		
E. Maintenance Cost for Two Years	1. 2.	
F. Total Maintenance Cost for Two Years Total E.1, E.2		
Total D, F		

11. Bid Information

PAYMENT

Payment shall be made on one invoice, due and payable forty-five (45) days after final delivery and acceptance.

12.Energy Produced at Proposed Orientation (kWhs/year)

PROPOSED ORIENTATION_____

DESIGN CONDUCTOR LOSS PERCENTAGE_____%

Month	Average Monthly Energy Production (kWh)
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	
Total	

APPENDIX B

Request for Acceptance of Alternate Component(s)

Component

Manufacturer

The above specified component meets all applicable standards and codes for use in the photovoltaic system that has been designed for this project.

_____
Authorized Signature

_____
Printed Name

_____ _____
Title Date

_____
Address

Attach manufacturer's specification sheets.

Send completed paperwork to:

Mr. Christopher Warfel, P.E.
ENTECH Engineering, Inc.
PO Box 871
Block Island, RI 02807

ENTECH Engineering, Inc. shall provide a written response regarding acceptance within three (3) days of receipt of this form, granting or denying acceptance of the alternate components.

APPENDIX C

Codes and Standards

Other Codes and Standards may apply. The bidder is responsible for installing a system that meets all applicable codes.

ANSI C84.1-1995, Electric Power Systems and Equipment- Voltage Ratings.

National Electrical Safety Code, IEEE/ANSI, C2-1993.

IEEE Std 100-1992, the New IEEE Standard Dictionary of Electrical and Electronic Terms (ANSI).

IEEE Std 519-1992, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

IEEE Standard 1374 Guide for Terrestrial Photovoltaic Power System Safety, Draft #7 (February 1997). This may be superceded by:

IEEE Standard 929

National Electrical Code, NFPA/ANSI 70, 1999.

UL 1741

The electrical design will conform to the National Electric Code (NEC 97). Article 690 of the NEC applies specifically to photovoltaic systems in regards to consideration for the safety, protection and control of such systems. Other articles of NEC that are also applicable include:

Article 110 Requirements for electrical installation.
Article 210 Branch circuit.
Article 230 Services.
Article 240 Overcurrent protection.
Article 250 Grounding.
Article 300 Wiring methods.
Article 310 Conductors for general wiring.
Article 339 Underground feeder and branch circuit cable.
Article 400 Flexible cords and cables.
Article 450 Transformer and transformer vault.
Article 480 Storage batteries.
Article 705 Interconnected electric power sources.
Article 720 Low voltage systems
Article 710 Over 600 volts, nominal, general.

1. Module

The modules shall meet or exceed the requirements of IEEE standard 1262-1995, Recommended Practice for Qualification of Photovoltaic (PV) Modules (April 12, 1996) and Underwriter Laboratories (UL) Standard 1703, Standard for Safety for Flat-Plate Photovoltaic Modules and Panels (May 17,1993).

2. Power Conditioning Unit/Inverter

The Inverter shall be UL listed (UL 1741 photovoltaic power systems) and it shall satisfy all of the latest applicable IEEE, ANSI, NEC and FCC requirements, including IEEE 1741.

Inverter-generated harmonics at the system's AC interface, at rated power, shall not exceed a total harmonic (current and voltage) distortion as specified in ANSI/IEEE 519-1992.

The Inverter shall not produce excessive Electromagnetic Interference (EMI) and shall be in compliance with FCC EMI regulations/guidelines, Part 15, Subpart J, FCC Regulations.

The Inverter shall be designed to minimize audible noise when the enclosure door is closed and minimize the transmission of noise/vibration through the enclosure mounts. The maximum Inverter audible noise at a point two (2) meters in front the Inverter shall be no more than 52 dba.

Array ripple shall be less than 3% RMM.

Output Voltage: As specified per installation ± 15%.

Output Frequency: Line synchronized 59 - 61 Hz. Tolerances shall be field adjustable and specified.

Maximum Current Harmonic Distortion from 30% to 100% of rated output: 5% Total Harmonic Distortion (THD).

Power Factor: 0.85 leading to 0.85 lagging.

Fault Indication and Ground Fault Interrupter (GFI): The Inverter shall shut down in the event of internal faults and/or component failures, and automatically or manually indicate the fault. A GFI shall be included on the DC side for automatically interrupting the fault path and disabling the array in case of a ground fault.

Transient and Surge Protection: Limited surge protection at the PV array shall be provided. Additional protection from vicinity lightning strikes and normal utility transients is required on both the DC and AC sections of the Inverter. The protective circuits and components shall assure that other components and circuits are shielded from any explosive failures of the protective components.

3. Balance of System

The balance of system includes, but is not limited to, conductors, connectors, fuses, disconnect switches, conduit and other items necessary to complete the proper installation of a solar electric system consistent with the applicable codes.

APPENDIX D

Commissioning Forms

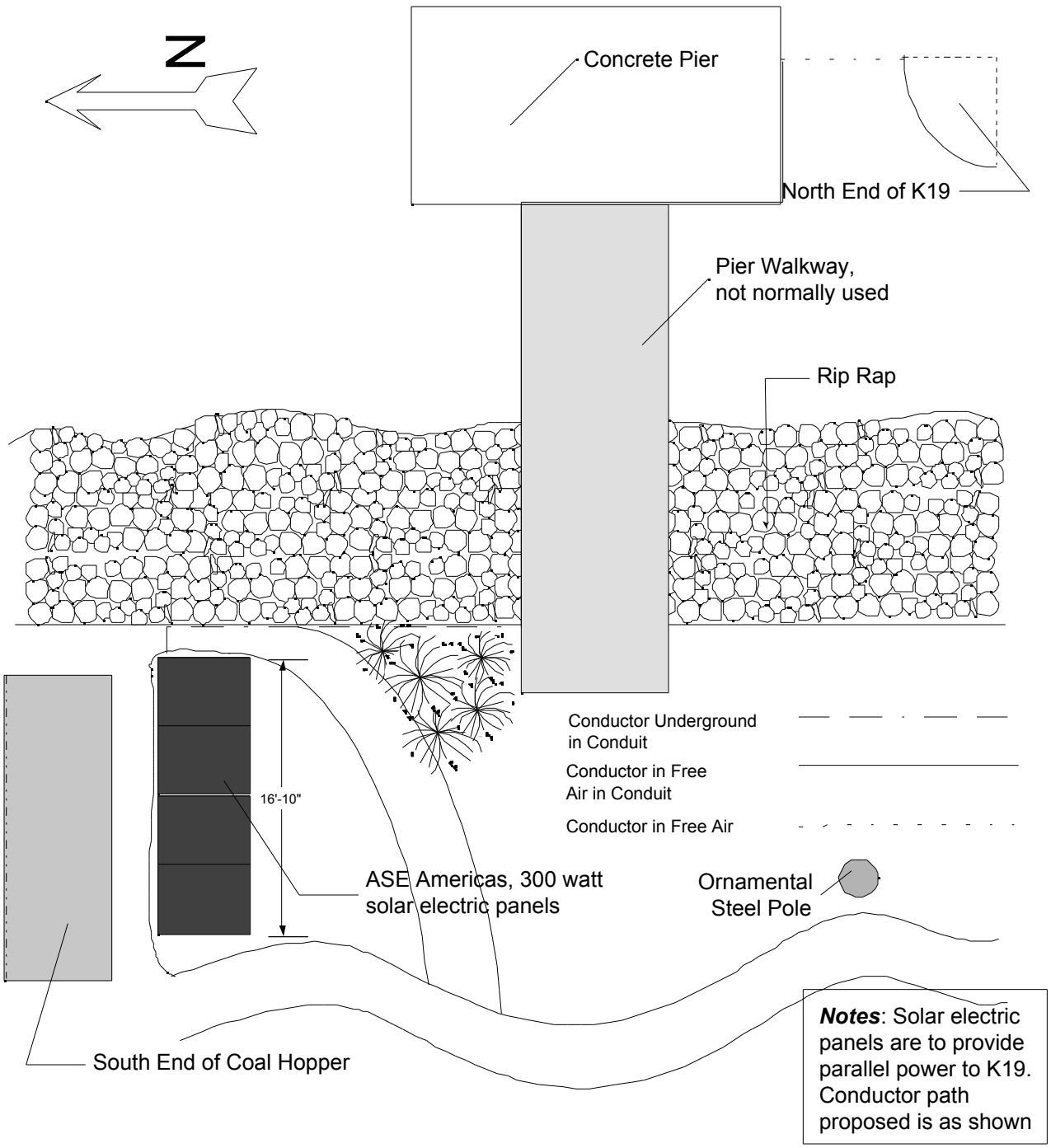
ACCCEPTANCE TESTING OF PHOTOVOLTAIC SYSTEM							
Installer name:							
Street address:							
City:	State:		Zip:				
Phone:	Fax:						
Email:							
Name of system owner or end user:							
Street Address:							
City:	State:		Zip:				
Phone:	Fax:						
PHOTOVOLTAIC SYSTEM INFORMATION							
Weather Conditions			Date of Test				
PV Module Information							
PV Module Manufacturer(s)			System DC Design Voltage				
PV Module Voltage	Module # in series		Parallel Array #				
PV Module Power Output @ STC			PV System Total Power Output				
Mounting Technology							
Array Orientation							
Siting Issues If Any							
Module Conductors Details							
Disconnect Switch(es): Module to Inverter							
Inverter							
Inverter Manufacturer/Model Number			Inverter Output				
Inverter to AC Load Circuit Panel Conductor Details							
Utility Interconnection							
Disconnect Switch(es): Inverter to AC Load Circuit Panel							
AC Load Circuit Panel Information			Metering				
Disconnect Switch from Utility							
Signage							
Utility Disconnect	GDFI				Bipolar Circuits		PV Disconnect
Energized Terminals Noted	PV System Information				Identification of Power Sources		Busbar or Connector Connection Equipment
	Imp	Vmp	Voc	Isc	PV	Utility	

Required Owner Documentation	
System Manual	Record Keeping
Additional Pertinent System Information	
Comment:	

APPENDIX E

Site Photos and Schematics

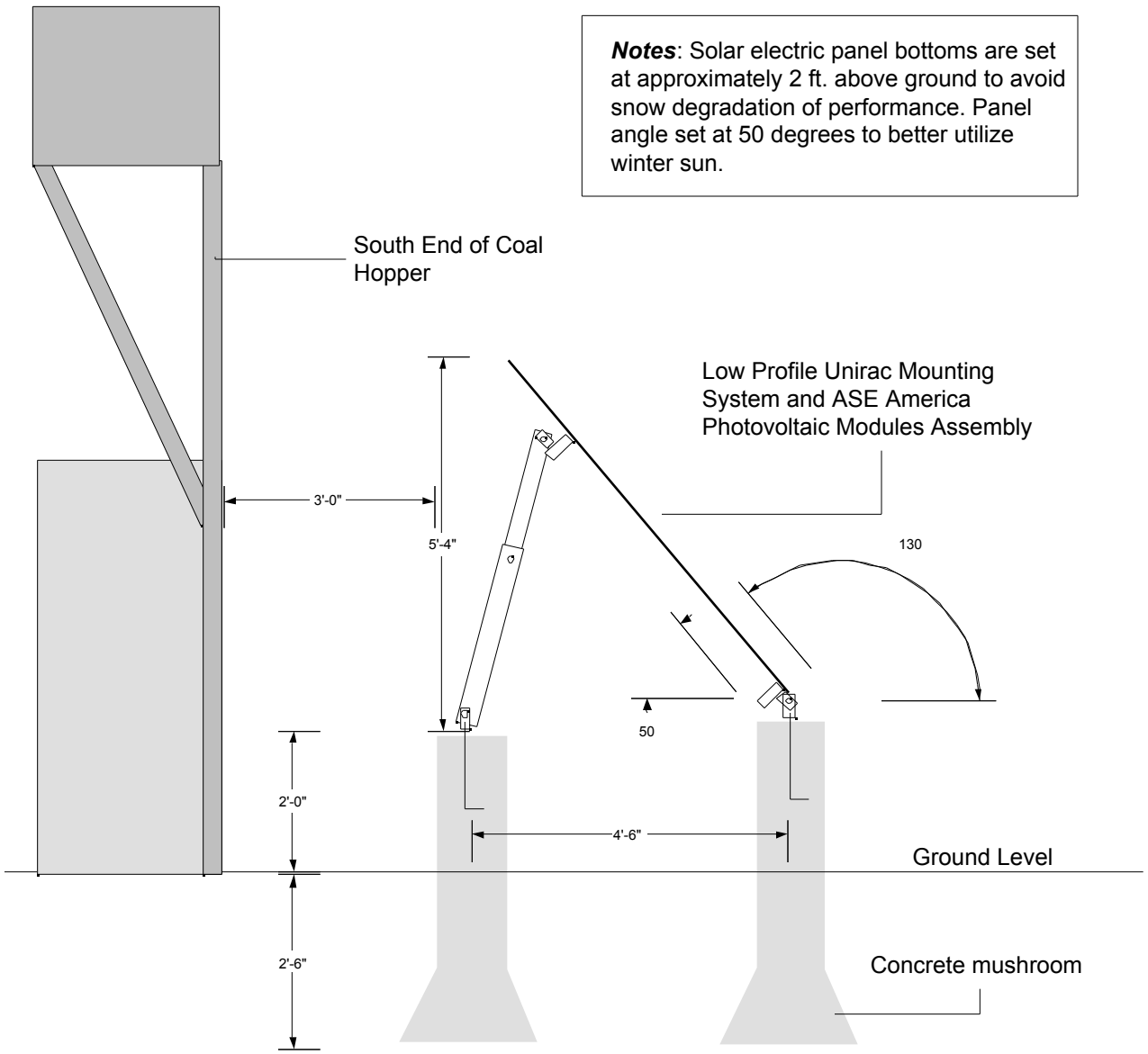
South side of Coal Handler



Notes: Solar electric panels are to provide parallel power to K19. Conductor path proposed is as shown

ENTECH	*Title:*	K19 Photovoltaic Project, Providence, RI		A-1 Site Plan Not To Scale
	Drawn by/date:			
	Checked by/date:			
	Notes:			

ENTECH Engineering, Inc. PO Box 871, Block Island, RI 02807 (401)466-8978V;(401)466-9827F,I
www.entech-engineering.com



ENTECH Engineering	*Title:*	K19 Photovoltaic Project, Providence, RI		A-2 East Profile
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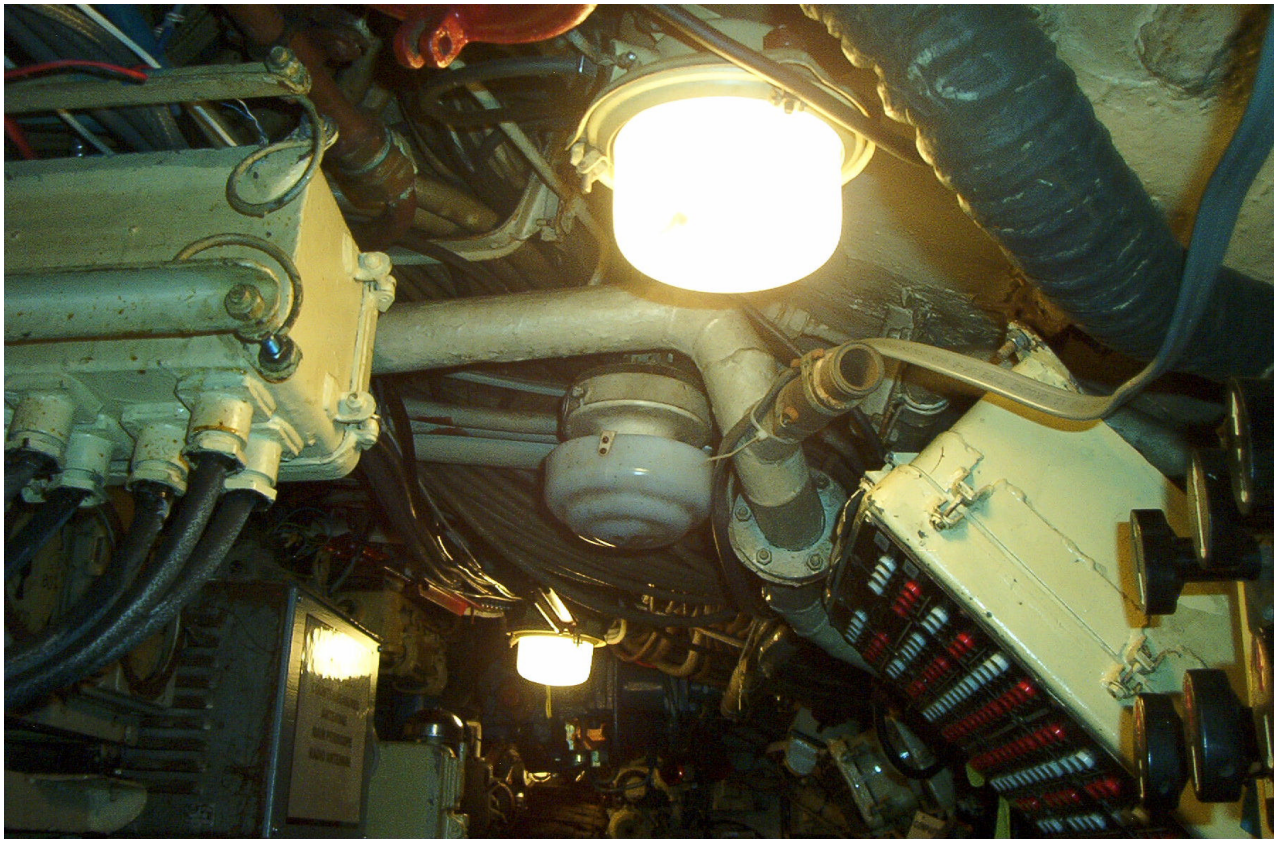
APPENDIX E

Light Fixture Types



TYPE ONE Fixture. Can accept CFL

TYPE TWO Fixture. Can accept LED

TYPE THREE Fixture. Can accept CFL

APPENDIX F

Lighting Analysis

nergy Efficient Lighting **ONLY LIGHTING IN THE SUBMARINE IS TO BE REPLACED UNDER THIS RFP**

	In place				Replacement				Incremental Demand Reduction
cket Trailer	Lighting	wattage	number	total	Lighting	wattage	number	total wattage	watts
	incan	40	2	80	cfl	10	2	20	60
	T12 fluor	72	3	216	T8 fluor	60	3	180	36
	Office Machines								
	Xerox	720	1	720	Xerox	720	1	720	0
	Microwave	1500	1	1500	Microwave	1500	1	1500	0
afety Trailer	Lighting	wattage	number	total			number		
	incan	40	2	80	cfl	10	2	20	60
	fluor	72	3	216	T8 fluor	60	3	180	36
	Computers	900	2	1800	Computers	900	2	1800	0
ubmarine	Lighting	wattage	number	total		wattage	number	total	
ompartment One									
utside String Lamps	incan	40	40	1600	cfl	10	40	400	1200
XIT Signs	cfl	14	6	84	led	2	6	12	72
ompartment Two-First Deck									
fficers Wardroom	incan	60	9	540	cfl	15	9	135	405
:ateroom	incan	60	12	720	cfl	15	12	180	540
EE NOTE (3)									
ompartment Two-Second Deck									
erthing	T12fluor	72	1	72	T8fluor	60	1	60	12
erthing	T12fluor	45	2	90	T8fluor	37	2	74	16
ompartment Two-Third Deck									
	fluor	72	4	288	T8fluor	60	4	240	48
ompartment Three-First Deck									
EE NOTE (1)	incan	40	10	400	cfl	10	10	100	300
ompartment Three-Second Deck									
EE NOTE (2)	incan	40	9	360	led	3	9	27	333

ubmarine, continued											
ompartment Four-First Deck											
EE NOTE (1)	incan	40	7	280		cfl	10	7	70		210
EE NOTE (2)	incan	40	4	160		led	3	4	12		148
ompartment Four-Second Deck											
EE NOTE (1)	incan	40	2	80		cfl	10	2	20		60
EE NOTE (2)	incan	40	11	440		led	3	11	33		407
ompartment Five-First Deck											
EE NOTE (2)	incan	40	7	280		led	3	7	21		259
ompartment Six-First Deck											
EE NOTE (1)	incan	40	4	160		cfl	10	4	40		120
	fluor	72	2	144		T8fluor	60	2	120		24
ompartment Seven-First Deck											
EE NOTE (1)	incan	40	1	40		cfl	10	1	10		30
EE NOTE (2)	incan	40	8	320		led	3	8	24		296
ompartment Eight-First Deck											
EE NOTE (2)	incan	40	5	200		led	3	5	15		185
ummary											
ubmarine Total Light Wattage				6,258	watts				1,593	watts	4,665 watts
ailers Total Wattage (w/o heating system)				4,612	watts				4,420	watts	192 watts
otal Complex Wattage (w/o heating system)				10,870	watts				6,013	watts	4,857 watts

OTE (1) This is the TYPE ONE fixture, which can accept a CFL
OTE (2) This is the TYPE TWO fixture, which can accept an LED
OTE (3) This is the TYPE THREE fixture, which can accept a CFL

APPENDIX G

Modeling of Backup Power Needs

Data Source, 1=design,2=historic	2
Design Conditions, 1=spring,2=summer,3=winter	3
PV Module Sun Tracking System, 1=yes,2=no	2
AC Power Conversion Efficiency	95%
DC Power Conversion Efficiency	100%
Design Storage Days	1
System Voltage	48
Wire Efficiency	98%
Batteries	
Battery Efficiency	90%
Maximum Discharge Depth	70%
Temperature Derate Factor	1
Selected Battery Capacity, Amp-Hours	350
Battery Voltage	6
System Efficiency	86%

		Peak Sun Hours			Design Current	
		-15 Latitude	Latitude	+15 Latitude	amps	amp-hours
January	winter	2.30	2.53	2.64	311.0	715.2
February	winter	2.95	3.10	3.10	264.8	781.2
March	winter	3.72	3.74	3.58	219.5	785.8
April	spring	4.53	4.34	3.96	181.2	717.6
May	spring	5.14	4.75	4.18	159.7	667.6
June	summer	5.38	4.90	4.26	152.6	650.0
July	summer	5.25	4.85	4.27	156.4	667.7
August	summer	4.95	4.75	4.33	165.8	718.1
September	summer	4.43	4.47	4.29	183.7	787.9
October	fall	3.77	4.02	4.06	202.2	762.3
November	fall	2.48	2.76	2.88	285.0	706.9
December	winter	2.01	2.26	2.39	343.5	690.4
	Design Conditions			2.39	*343.5*	

Load Characteristics

DC Load

Description	Load Current	Load Voltage	Power	Daily Duty Cycle	Spring/Fall Weekly Duty Cycle	Spring/Fall Amp-Hour Load	Summer Weekly Duty Cycle	Summer Amp-Hour Load	Winter Weekly Duty Cycle	Winter Amp-Hour Load
	Amps	Volts	Watts	hours/day	days/week	A-H/Day	days/week	A-H/Day	days/week	A-H/Day
Lights	0	48	0	0	0	0	0	0	0	0
Motors	0	48	0	0	0	0	0	0	0	0
Other	0	48	0	0	0	0	0	0	0	0
Other	0	48	0	0	0	0	0	0	0	0
Total	0		0			0		0		0

AC Load

Description					Spring/Fall		Summer		Winter	
Lighting	39.00	120	4680	10.00	5	733.1	7	1026.3	3	439.8
Boiler Circulators	7.50	120	900	14.40	5	203.0	0	0.0	7	284.2
	0.00	120	0	18.00	7	0.0	7	0.0	7	0.0
	0.00	120	0	8.00	7	0.0	7	0.0	7	0.0
	0.00	120	0	5.00	7	0.0	7	0.0	7	0.0
	0.00	120	0	2.00	7	0.0	7	0.0	7	0.0
	0.00	120	0	2.00	7	0.0	7	0.0	7	0.0
	0.00	120	0	1.00	7	0.0	7	0.0	7	0.0
	0.00	120	0	5.00	7	0.0	7	0.0	7	0.0
	0.00	120	0	5.00	7	0.0	7	0.0	7	0.0
Total			5,580			936.1		1026.3		724.1

Total DC Load Power, watts	Total AC Load Power, watts	Peak Draw Amps	Total Annual Energy Needs
0	5,580	116.3	14,383 kWh
House Amp-Hours Load	**System Amp-Hour Load**	**System Watt-Hour Load**	**Average Monthly Energy Needs**
Amp-Hour/Day	Amp-Hour/Day	Watt-Hour/Day	
724.1	820.9	39,405	1,199 kWh

Battery Size

System Amp-Hour Load	820.9
Battery Capacity Required, Amp-Hours	1172.8
Batteries System Configuration	
Number in Parallel	3.0
Number in Series	8.0
Total Batteries Required	24.0
System Capacity	1050
Usable Battery Capacity, Amp-Hours	735

Array Sizing as Specified

Installed Module Capacity	1200 watts	Module Subarrays in Series	7.0
Number of Installed Modules	12	Modules in Parallel	2.0
Module Voltage	12	Total Modules Required	14
Module Current	7.7	Watt	86
System Array Voltage	78	Module Dimensions-width	26 inches
Watts per Parallel Array	600.6 watts	length	56.00 inches
		System Dimensions-width	32.67 feet
		length	4.33 feet
		Area	141.6 sq. feet

Array Sizing as Stand Alone System

Module Characteristics

Nominal Voltage	0 volts
Highest Temperature Module Voltage	0 volts

	Standard Conditions	Open Circuit
Voltage	0 volts	0.0 volts
	Standard Conditions	Short Circuit
Current	7.70 amps	0 amps

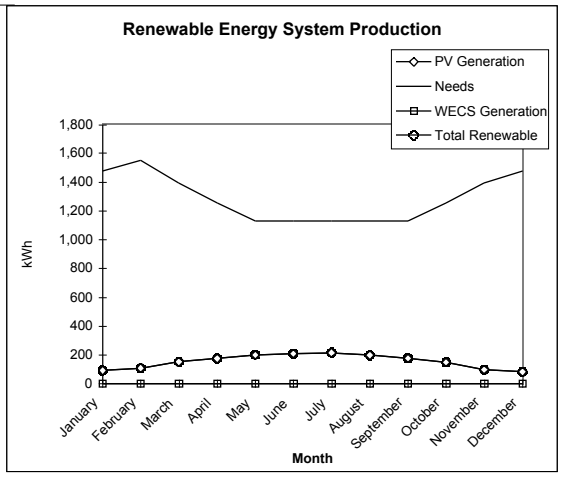
Module Derate Factor	0 .9= Cystalline, .7 = Amorphous
Usage Design Current	343.5 amps
Usage Derated Design Current	0.0 amps
Modules in Parallel	0.0
Modules in Series	0
Total Modules Required	0.0

Modules in Parallel		Modules in Series	
Array Short Ciruit Current	0.0 amps	Array Rated Voltage	0 volts
Array Open Circuit Current	0.0 amps	Array Open Circuit Voltage	0 volts

Renewable Energy System Design Characteristics and Performance

	Photovoltaic System	Wind Energy Conversion System
Output, watts	1200	0
Tracking Performance Increase	0%	

	Load			System Output	
Month	Daily watt-hours	Monthly kWh		Daily watt-hours	Monthly kWh
January	47,613	1,476	pv	2,742	85
			wecs	0	0
February	49,994	1,550	pv	3,574	100
			wecs	0	0
March	44,994	1,395	pv	4,579	142
			wecs	0	0
April	40,495	1,255	pv	5,439	163
			wecs	0	0
May	36,445	1,130	pv	6,098	189
			wecs	0	0
June	36,445	1,130	pv	6,527	196
			wecs	0	0
July	36,445	1,130	pv	6,512	202
			wecs	0	0
August	36,445	1,130	pv	6,037	187
			wecs	0	0
September	36,445	1,130	pv	5,551	167
			wecs	0	0
October	40,495	1,255	pv	4,541	141
			wecs	0	0
November	44,994	1,395	pv	2,995	90
			wecs	0	0
December	47,613	1,476	pv	2,452	76
			wecs	0	0
Annual Total	315,328	9,775	pv	57,046	1,737
			wecs	0	0



HYBRID DESIGN PARAMETERS

Array to Load Ratio 0.00

Hybrid Design or PV Stand-alone: Consider Hybrid or Interconnect

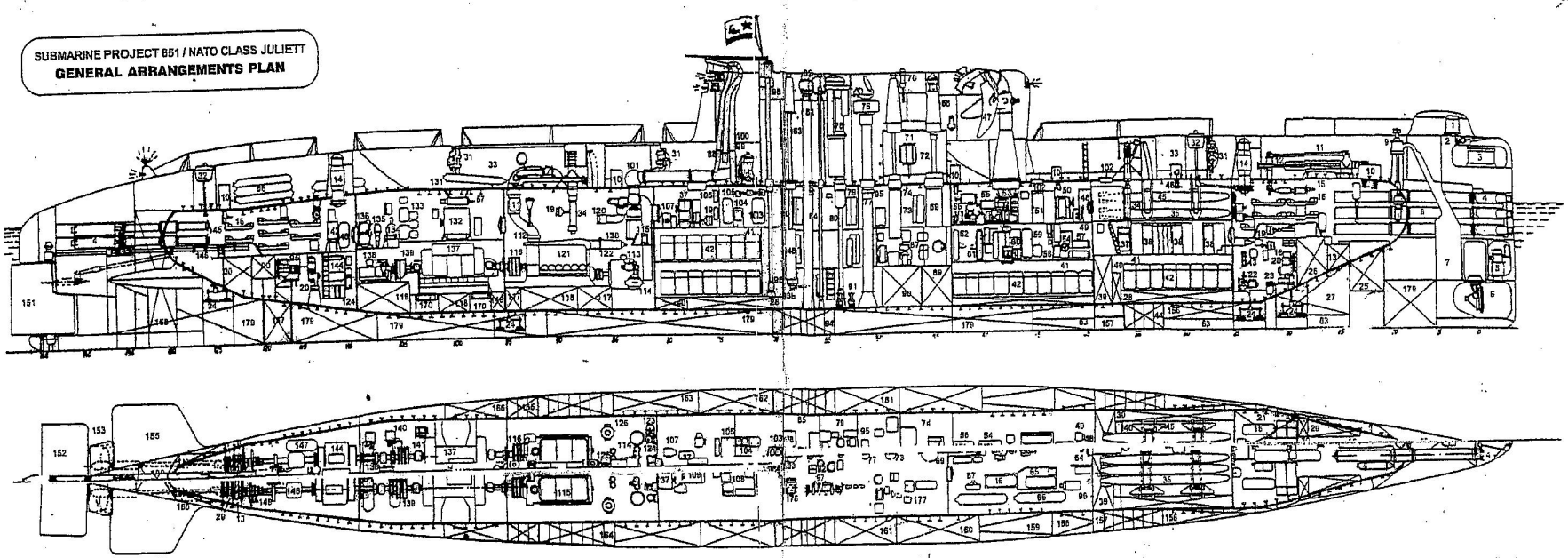
	Energy Needs	Energy Produced	Photovoltaic	WECS	Generator	Total
kWh/year	9,775		1,737	0	0	1,737
Average Wh/Day	26,781		4,759	0	0	4,759

APPENDIX H

Diagrams of Juliet 484 Submarine

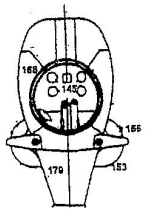
SUBMARINE PROJECT 651 / NATO CLASS JULIETT

GENERAL ARRANGEMENTS PLAN



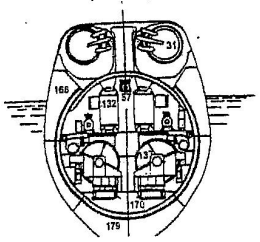
CROSS SECTION TO 127 FRAME LOOKING TO AFT

Разрез по 127 шп / см в корму /



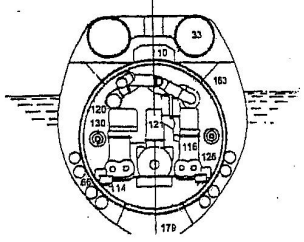
CROSS SECTION TO 101-102 FRAME LOOKING TO AFT

Разрез по 101-102 шп. шп. / см. в нос /



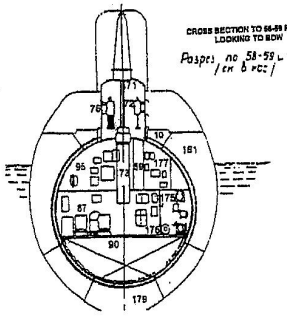
CROSS SECTION TO 83-84 FRAME LOOKING TO AFT

Разрез по 83-84 шп шп / см в корму /



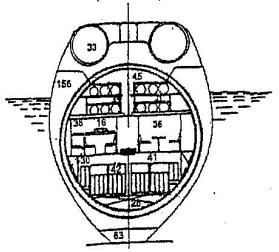
CROSS SECTION TO 58-59 FRAME LOOKING TO BOW

Разрез по 58-59 ш. шп / см в нос /



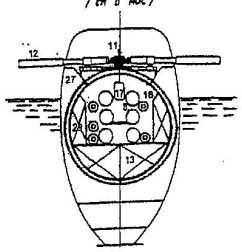
CROSS SECTION TO 31 FRAME LOOKING TO BOW

Разрез по 31 шп / см. в нос /



CROSS SECTION TO 15 FRAME LOOKING TO BOW

Разрез по 15 шп / см в нос /



ЧЕРТЕЖ ОБЩЕГО РАСПОЛОЖЕНИЯ ПОДВОДНОЙ ЛОДКИ ПРОЕКТА 651

SUBMARINE PROJECT 651 / NATO CLASS - JULIETT

GENERAL ARRANGEMENTS PLAN

1 Hydro acoustic station MG-23
2 Towing mast
3 Underwater listening system MG-10
4 Cutwater shield
5 Sound fixing and ranging station "Plutonium"
6 Sound fixing and ranging station "Arktika-M"
7 Anchor chain box
8 Torpedo Apparatus
9 Warping capstan
10 Ventilation valve of the Main Ballast tanks
11 Bow diving planes removal system
12 Bow diving planes
13 Water round torpedo tank
14 Access hatch with twin trunk
15 Bow diving planes hydraulic drive
16 Bunks
17 Main torpedo fire control system apparatus
18 Torpedo firing cylinder
19 Air-conditioning cooler
20 Trim and drain pump
21 Fuel tank No. 1
22 Freezer system compressor
23 DDK system
24 Main ballast tank's Kingston with hydraulic drive
25 Main ballast tank No. 1
26 Bow trim tank
27 Main ballast tank No. 2
28 Fuel tank
29 RTS tank
30 Fresh water tank
31 Container's ramp
32 Emergency telephone buoy
33 Missiles container
34 Hydraulic of the container block
35 Reserve torpedo
36 Officer's wardroom
37 Batteries automatic control
38 4-berthes officer's cabins
39 Substitution bow missiles tank
40 Irrigation tank
41 Battery compartment
42 Batteries (removed on 484)
43 Freezer condenser
44 Torpedo tube flooding tank
45 Torpedo tube
46 Ventilation valve hydraulic machine
47 Antenna "Argument"
48 Head
49 Economy electric engine power controller
50 Lightning system power controller
51 Captain's cabin
52 Middle quarters access hole
53 Guidance device of the "Argument" system
54 "Argument" system guidance drive pump
55 Converter
56 Pump drive of the "Argument's" stabilization system
57 Inverter
58 Hydrogen after combustion furnace of the battery ventilation system
59 Coder/decoder of the "Argument" system
60 Oxygen regeneration system KDC
61 "Argument" control panel
62 "Argument" autopilot control
63 Ballast enclosure
64 Hydraulic control for propelling electrical system
65 Motor's cabin
66 High-pressure air balloon
67 Direct current circuit panel
68 Astronavigation periscope "Lira"
69 "Lira's" shaft
70 Electromagnetic clutch
71 Zenith periscope
72 "Lira" hydraulic system
73 Zenith periscope shaft
74 Navigation room
75 Antenna "Uspex"
76 Conning tower, pressure room
77 "Uspex" hydraulic system
78 RDP system
79 Hydro acoustic room
80 RDP hydraulic system
81 Antenna "Nakat"
82 Antenna "Uspex" post 2
83 Periscope MMA-10
84 "Uspex" hydraulic system post 2
85 Radar room
86 PMA-10 hydraulic system
87 Gyro station
88 Diesel exhaust mast
89 Quick-diving tank
90 Food tank No. 2
91 Kingston of the batteries cooling system
92 Pneumatic hydraulic accumulator of the hydraulic system
93 Hydraulic system pump
94 Adjusting (equalizing) tank
95 Torpedo fire control system apparatus enclosure
96 Freezer air
97 Elbow post
98 Antenna "Topol"
99 Diesel air flap valve
100 Snorkel system pipes
101 Diesel air valve
102 Batteries loading hatch
103 Galley
104 Table, sink, freezer
105 Shower
106 Gas analyzer
107 Economic electric engine panel
108 2-berthed cabin
109 Propelling electric system switch
110 Main diesel exhaust flap valve & gas pipe
111 Universal flap valve
112 Sound insulating compensator
113 Machine cooling system filter
114 1D43 engine oil cooler
115 1D43 engine
116 Rubber pneumatic clutch
117 Circulation oil tank
118 Pure oil tank
119 VCH-250 pump
120 Ventilation fans
121 1D42 engine
122 PG-142 generator
123 Oil separator
124 Pump of the screw oil system
125 Oil centrifugal filter of the 1D43
126 Rough oil filter of the 1D43
127 Fresh water cooler
128 1D42 engine oil cooler
130 Diesel compressor
131 Starting balloon
132 Control panel of the PG-141 electrical engines
133 Cooling electrical equipment
134 Cooling system evaporating apparatus
135 Centrifugal pump of the air-conditioning syste
136 Compressor of the cooling system
137 Electrical engine PG-141
138 Electrocompressor of the high pressure air sys
139 Rubber pneumatic clutch with air distributer
140 Fresh water distiller
141 Fresh water compressor
142 Centrifugal pump of the air conditioning syste
143 Control panel of the energy-saving electric en
144 Energy-saving electric engine PG-140
145 400mm torpedo apparatus
146 Vertical rudder drive
147 Toilet system balloon
148 Main-thrust bearing
149 Oil pump cooler
150 After hydro planes drive
151 Vertical rudder
152 After hydro planes
153 Thrust-augmenting nozzle
154 Propeller
155 Stabilizing tail
156 Main ballast tank No. 3
157 Emergency ballast tank No. 4
158 Main ballast tank No. 5
159 Main ballast tank No. 6
160 Main ballast tank No. 7
161 Main ballast tank No. 8
162 Main ballast tank No. 9
163 Main ballast tank No. 10
164 Emergency ballast tank No. 11
165 Aft missiles compensation tank
166 Main ballast tank No. 12
167 Aft trimming tank
168 Main ballast tank No. 13
169 Main ballast tank No. 14
170 Shaft line air cooling system
171 Electric engine PG-141 fan
172 Electric engine exciter V-11
173 Exhaust muffler
174 Air-conditioning cold water centrifugal pump
175 Aggregate enclosure
176 "Lira-2" system
177 Planesman post
178 Midship ladder
179 Diesel fuel tanks